Mains transformer 190 V... 400 V

9803 720 81002

FILING INSTRUCTIONS

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X – ray generator

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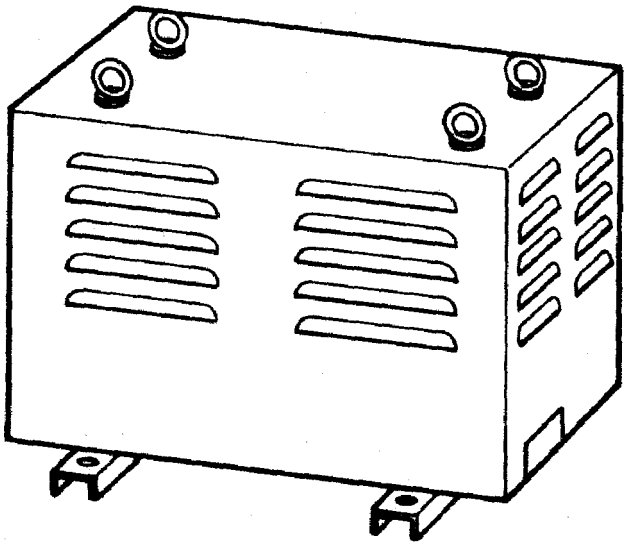
SERVICE MANUAL
742
UNIT

Mains transformer 190V...400V

9803 720 81002

Techn. No. 4512 103 76651



012L96

Transformer permitting the X-ray generator
to be operated on 190V...400V three-phase supplies.

DMC Hamburg

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SERVICE MANUAL - UNIT

Mains transformer 190V...400V

Author: T. Frenschek

Type No: 9803 720 81002
Techn. No: 4512 103 76651

In case there are any questions concerning this manual,
please send this LOPAD via fax to 49/(0)40/5078 2481

File: Mains Transformer 190V 400V_40464 AB

List of pages and drawings (LOPAD)

Manual Order No: 4512 103 40464
released: 09/2004

0.5		223 mm	(Rosa Karton)
1			
2			
3...11	(04.0)		
Z-2	(03.0)	A4	
Z-3	(03.0)	A4	
Z-4	(04.0)	A4	
Z-5	(04.0)	A4	

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1. General

All X-ray generators are exclusively intended to be connected to three-phase supplies 400 V. The main transformer is used as an adaptation transformer for three-phase supplies with voltages between 190V and 350 V and permits the generator to be operated in power classes of up to 100kW. Be sure to watch the influence of the transformer on the internal mains resistance.

1.1. Compatibily

The mains transformer 190V ... 400V is compatible with generator:

- OPTIMUS RAD / RF 9890 000 0218x
- Power distribution unit 9890 000 0260x
- Basis OPTIMUS C 9890 000 0219x
- Velara 9890 000 0210x

2. Planning data

2.1. Type of mains

Four conductor three-phase mains symmetrical with respect to earth; voltage 190V to 400V; 50/60 Hz; pre-fused. Refer to the table under 6.3.1 “Connecting the mains transformer”.

The star point of the transformer must not be connected with the neutral conductor.

2.2. **Earth-leakage circuit breaker** (RCD)

Depending upon local regulations it may be necessary to provide the following earth-leakage circuit breaker additionally between main switch and X-ray installation:

Siemens earth-leakage circuit breaker N 5SZ type B
order No. 5SZ3 466 0KG00

(rated fault current 30 mA, rated current 63A).

2.3. Surge arrester WN

In case the installation complies with IEC 60601-1-2, a surge arrester does not have to be installed.

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3. Mains resistance

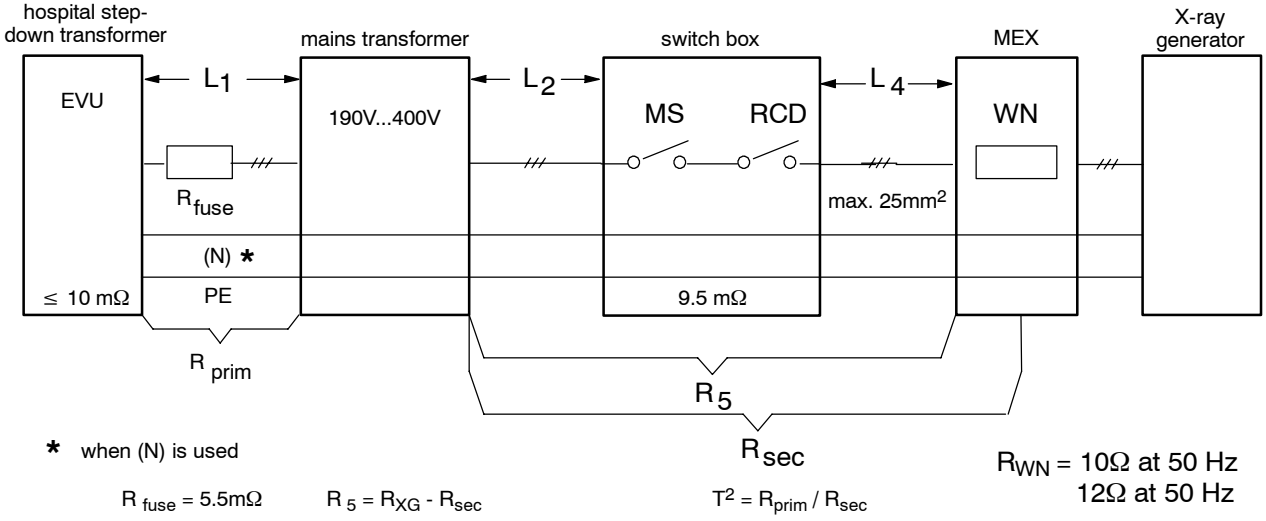
3.1. Calculating the mains resistance

The sum of Ro, R1, Rtr, R2, R3 and R4 must be less or equal the RXG required.
With higher internal mains resistances the generator output is reduced respectively, depending on mains voltage supply as well.

NOTE

The cross section of L4 must not exceed 25mm^2.

$\Sigma R_0 + R_1 + R_{TR} + R_2 + R_3 + R_4 < R_{XG}$ see table 3.3.



- R_0 and U_{input} designates the mains resistance or, respectively, the voltage on the hospital step-down transformer which must be measured at the mains distribution board by the electrician responsible.
- R_1 is dependent on the length of lead L_1 between hospital step-down transformer and mains transformer and upon the cross section selected, so:
  $R_1 = L_1 \times R_{cu} + R_{fuse}$ R_{cu} from table 6.3.2.
- R_{TR} $Ri_{primary}$ from the mains transformer see table 6.3.1.
- R_2 is dependent on the length of lead L_2 between mains transformer and the switch box and upon the cross section selected, so:
  $R_2 = L_2 \times R_{cu}$ R_{cu} from table 6.3.2.
- R_3 consists of upstream elements such as:
  - EMERGENCY-OFF 4.0mΩ
  - Earth-leakage circuit breaker 5.5mΩ
- R_4 is dependent on the length of lead L_4 between the switch box and cabinet rear cover and upon the cross section selected, so:
  $R_4 = L_4 \times R_{cu}$ R_{cu} from table 6.3.2.
  The resistance already consider the go and return line so that the calculation can be based on single cable lengths.
- R_5 is dependent on the resistance R_2 and R_3 and R_4
- R_{XG} is the specified mains resistance of the X-ray generator see table 3.3.

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3.2. General concerning the mains resistance

For the resistances and the cross sections of leads refer to the details in the subsystem documentation of the generator.

When the mains transformer 190V–400V is installed, no fuse must be provided in the switch box. In this case the fuse must be placed between the step–down transformer of the hospital and the mains transformer.

The mains transformer must be positioned in such a way that the distance L_1 between the step-down transformer of the hospital and the mains transformer is as small as possible.

3.3. Resistance (RXG) of the X-ray generator with various power classes on 400V supplies

50 kW	65 / 80 kW	100 kW
≤ 300 m Ω	≤ 200 m Ω	≤ 150 m Ω

3.4. Calculation of the resistances

Based on the maximum permissible mains resistances specified in the table above
the following calculation gives an example for a 80KW generator:

Measured input voltage	U_{input} :	222 V_{ac}
Output voltage	U_{output} :	400 V_{ac}
Internal resistance switch box	R_3 :	9.5 mΩ
Generator resistance	R_{XG} :	200 mΩ (see table 3.3.)
Length of lead for L_2 :	30 m, AWG (American wire gauge) 3 → R_2 = 39.3 mΩ	
Length of lead for L_4 :	15 m, AWG (American wire gauge) 2 → R_4 = 15.6 mΩ	

$T = U_{input} / U_{output} = 222\ V_{ac} / 400\ V_{ac} = 0.55 \rightarrow Ri_{Tr} = 19.2\ m\Omega$ (see table 6.3.1)

$R_5 = R_2 + R_3 + R_4 = 39.3\ m\Omega + 9.5\ m\Omega + 15.6\ m\Omega = 64.4\ m\Omega$

$R_{sec} = R_{XG} - R_5 = 200\ m\Omega - 64.4\ m\Omega = 135.6\ m\Omega$

$R_{prim} = T^2 \times R_{sec} = 0.3 \times 135.6\ m\Omega = 40.68\ m\Omega$

$R_1 = R_{prim} - R_{Tr} = 40.68\ m\Omega - 19.2\ m\Omega =$ **21.48 mΩ**

The specified length of lead for the distance between hospital step-down transformer and mains transformer is $L_1 = 5.0$ m.

To determine the cable cross section for L_1 (specified 5.0m), R_{fuse} (5.5 mΩ) and R_0 (10 mΩ) must be deducted from the calculated R_1 (21.48 mΩ) to find the respective R_{CU} for the cable cross section to be found.

$R_{cu} = (R_1 - R_{Fuse} - R_0) / L_1$

$R_{cu} = (21.48\ m\Omega - 5.5\ m\Omega - 10\ m\Omega) / 5.0\ m = 5.98\ m\Omega / 5.0\ m =$ **1.19 mΩ / m**

Based on the table on page 11 the cable cross section (see table 6.3.2.) for AWG 2 (American wire gauge) can be determined for the calculated $R_{CU} = 1.19\ m\Omega / m$ for L_1.

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4. Introduction and technical data

4.1. Technical data

4.1.1. Mechanical data

Crate / Box	Dimension (mm)			Weight (Newton) (10 N = 1 Kg)
	Length	Width	Height	
Packed	800	660	880	24.6
Transport	800	660	880	24.6
Installed	600	400	580	22.0

4.1.2. Environmental data

	Operation	Stock / Transport
Temperature in °**Celcius**	0 / + 40	– 40 / + 75
Temperature in °**Celcius** / **hour**	N / A	N / A
Humidity in % (non-condensing)	5 / 95	5 / 95
Gradient in % / **hour**	N / A	N / A
Vibrations / Shock range in **Hz**	5 – 500	5 – 500
Vibrations / Shock amplitude in **mm**		
Vibrations / Shock acceleration in **g**	0.25 peak	1.0 peak
Shock acceleration in **g**	5 peak	30 peak
Shock pulse duration in **msec**	11	11
Air pressure in **Hecto-pascal**	700 / 1100	700 / 1100

Acoustic noise level : N / A
Air cooling : N / A

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4.1.3. Electrical data

Equipment related:

Power required short-time	:	200 kVA
Power required continuous	:	44 kVA
Nominal voltages	:	U_{prim} = 190 Vac - 350 Vac
Nominal current	:	I_{secmax} = 290 A, I_{prim} is depending on T^2 of the mains transformer
Nominal frequency	:	50 Hz / 60 Hz
Heat emission	:	
standby	:	360 W (1 Joule / s = 1 Watt)
in operation	:	2.7KW (1 Joule / s = 1 Watt)

NOTE

The data given below are only applicable for products that are directly supplied from the mains. In case of indirect supply these data can be ignored.

Mains supply related:

Supply configurations	:	3-phase Y, 4 wires
Hospital transformer resistance	:	≤ 10 mΩ
Voltage variation	:	max. 3% variation at the hospital transformer
Static frequency variation	:	+/- 0.5 Hz

4.2. Tools / material required

Standard set of service tools

4.3. Safety information

The general legal and factory safety recommendations for this X-ray equipment and the following recommendations must be strictly observed!
Start of installation, operation and maintenance work and especially electrical work must only be executed by trained and authorized persons. This equipment must only be serviced by properly educated service specialists who have received general and system-specific training as performed by Philips Medical Systems.

WARNING

The hospital step-down transformer must be switched OFF during replacement work.
Any X-ray unit produces ionizing radiation which may be harmful if not properly controlled. Therefore, it is recommended that this equipment be operated in accordance with the guidelines set down by the national council on radiation protection.

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5. Dimensions and weights

See drawing Z-2

6. Installation

6.1. General Installation

Secure the transformer to the floor with the appropriate fixing material (not included in the scope of delivery). Check the loading capacity of the floor at the site of installation.

Use no single conductors for establishing the connection - observe national rules and regulations.

Cable terminals with an inside diameter for M8 screws are required for fixing the mains feeders to the terminal board of the transformer (not included in the scope of delivery).

6.2. Installation with the X-ray generator

Drawing Z-3 shows the winding taps and the connection terminals of the mains transformer. Primary and secondary connections should be established on the right-hand side of the connection terminals.

The star point (X,Y,Z) of the transformer must not be connected. The block wiring diagram Z-4 shows the connection between mains transformer 190V ... 400V and the X-ray generator.

NOTE

According to PMS standard UXW 13600 class S0 a dedicated, low impedance, permanently installed connection, fed in by the hospital step-down transformer to supply large systems like MR, CT, X-ray systems is required. Recommended is the cable type NYC (W) Y.

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6.3. Connecting the mains transformer

Before the mains transformer must be connected with the output of the hospital step-down transformer, the mains output of the hospital step-down transformer must be measured.

This voltage must be divided by the output voltage of the mains transformer. With this factor (T) the connection terminals for the input and output can be determined by means of the table below.

T = voltage measured / output voltage

Example: T = U_{input} / U_{output} = 220 V_{ac} / 400 V_{ac} = 0.55 (380V for all SCP / OMCP and Medio generators)

For the calculated T of 0.55 the connection terminals input (WU L -4) and output (WU L -10) can be determined with the table below (6.3.1).

6.3.1. Table “Connecting the mains transformer”

Input WU Vac	Output WU L -9 **T**	Output WU L -10 **T**	**T^2**	R_{Tr} $Ri_{primary}$ [mΩ]	50 kW	65 / 80 kW **Fuse (A)**	100 kW
L -1		0,.48	0.23	19.9	80	125	X
195–200	0.50		0.25	17.2			125
L -2		0.50	0.25	19.9	80	100	125
205–211	0.53		0.28	17.2			
L -3		0.52	0.27	19.7	80	100	125
212–218	0.54		0.30	17.0			
L -4		0.55	0.30	19.2	80	100	125
226–232	0.58		0.34	16.5			
L -5		0.58	0.33	18.9	63	100	125
236–242	0.61		0.37	16.2			
L -6		0.60	0.36	18.7	63	100	125
246–253	0.63		0.40	16.0			
L -7		0.63	0.39	18.3	63	80	125
256–263	0.66		0.43	15.6			
L -8		0.68	0.74	10.2	50	63	80
352–361	0.90		0.82	7.5			

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6.3.2. Table for cross sections and resistances of leads

AWG (American wire gauge)	Diameter	Copper cross section mm_2	Resistance RCU double length in m Ω / m
6 / 0	14,733	170, 48	0,21
5 / 0	13,120	135, 20	0,26
4 / 0	11,684	107, 22	0,33
3 / 0	10,405	85, 03	0,41
2 / 0	9,266	67, 43	0,52
1 / 0	8,252	53, 48	0,65
1	7,348	42, 41	0,83
2	6,544	33, 63	1,04
3	5,827	26, 67	1,31
4	5,190	21,15	1,65
5	4,621	16,77	2,09

Attention:

It is recommended that the **low leakage inductivity** cables **type NYC** (W) **Y** be used.
Refer to 6.2.

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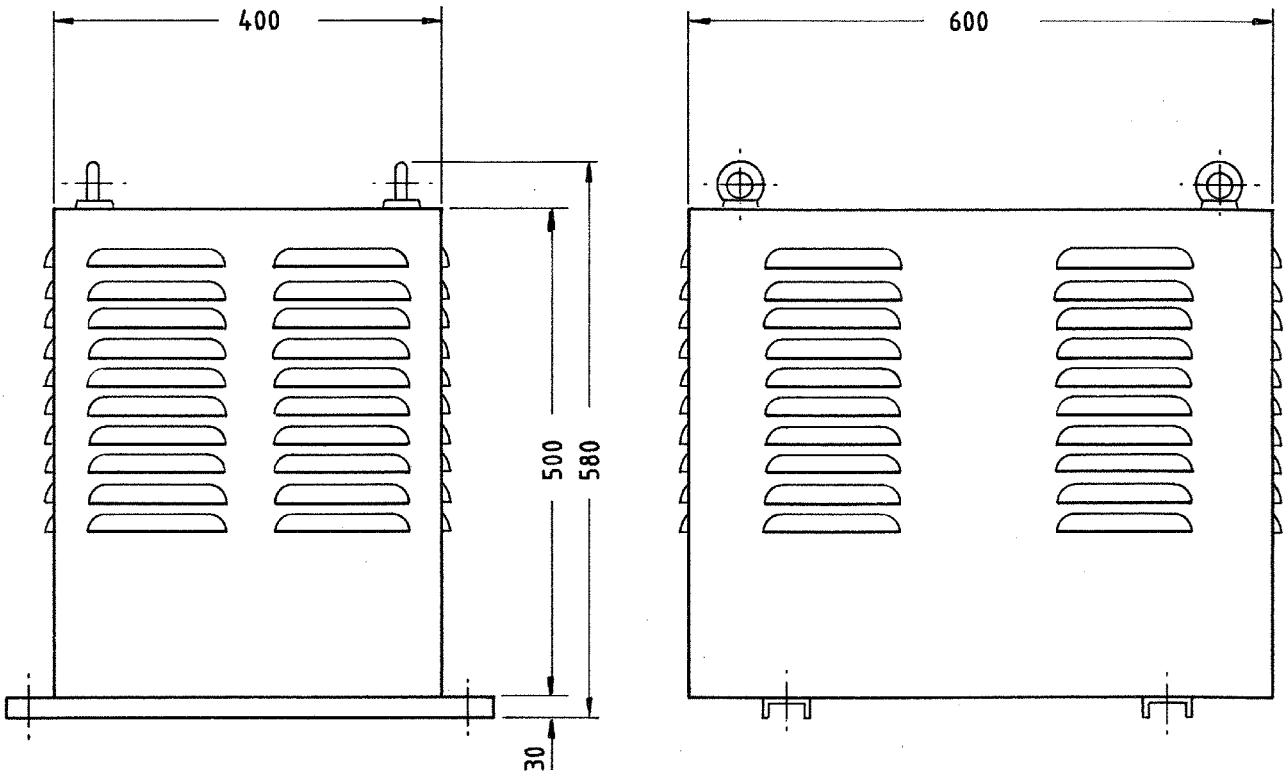

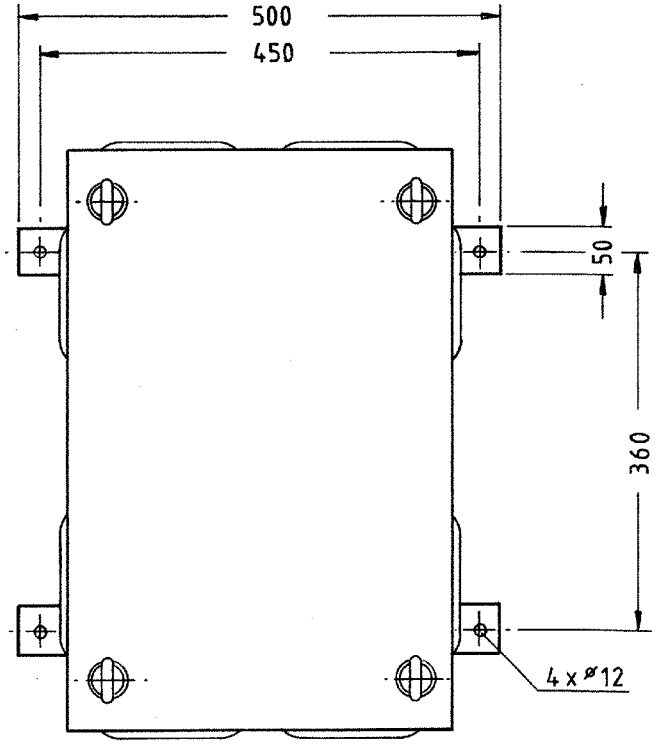

WEIGHT : 200 kg

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Mechanical dimensions

Mains transformer 190V ... 400V

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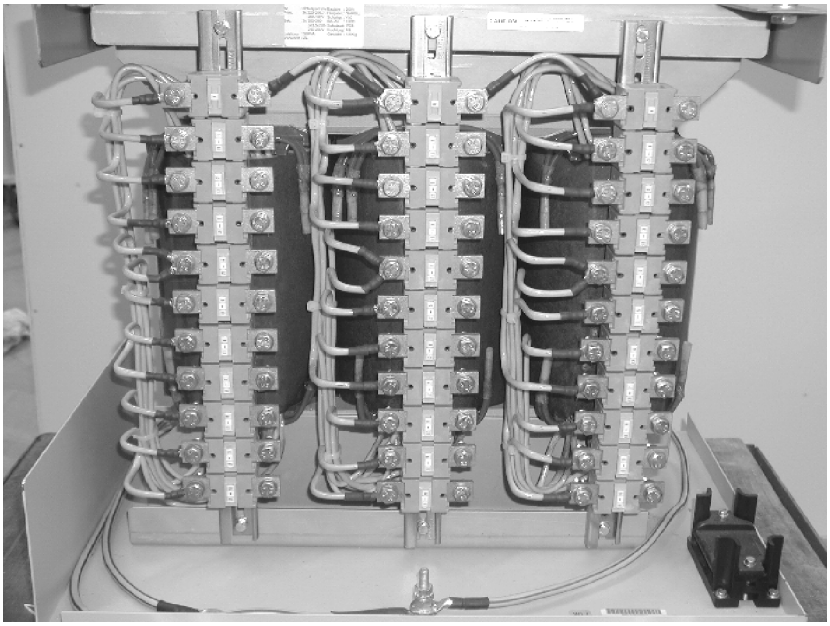

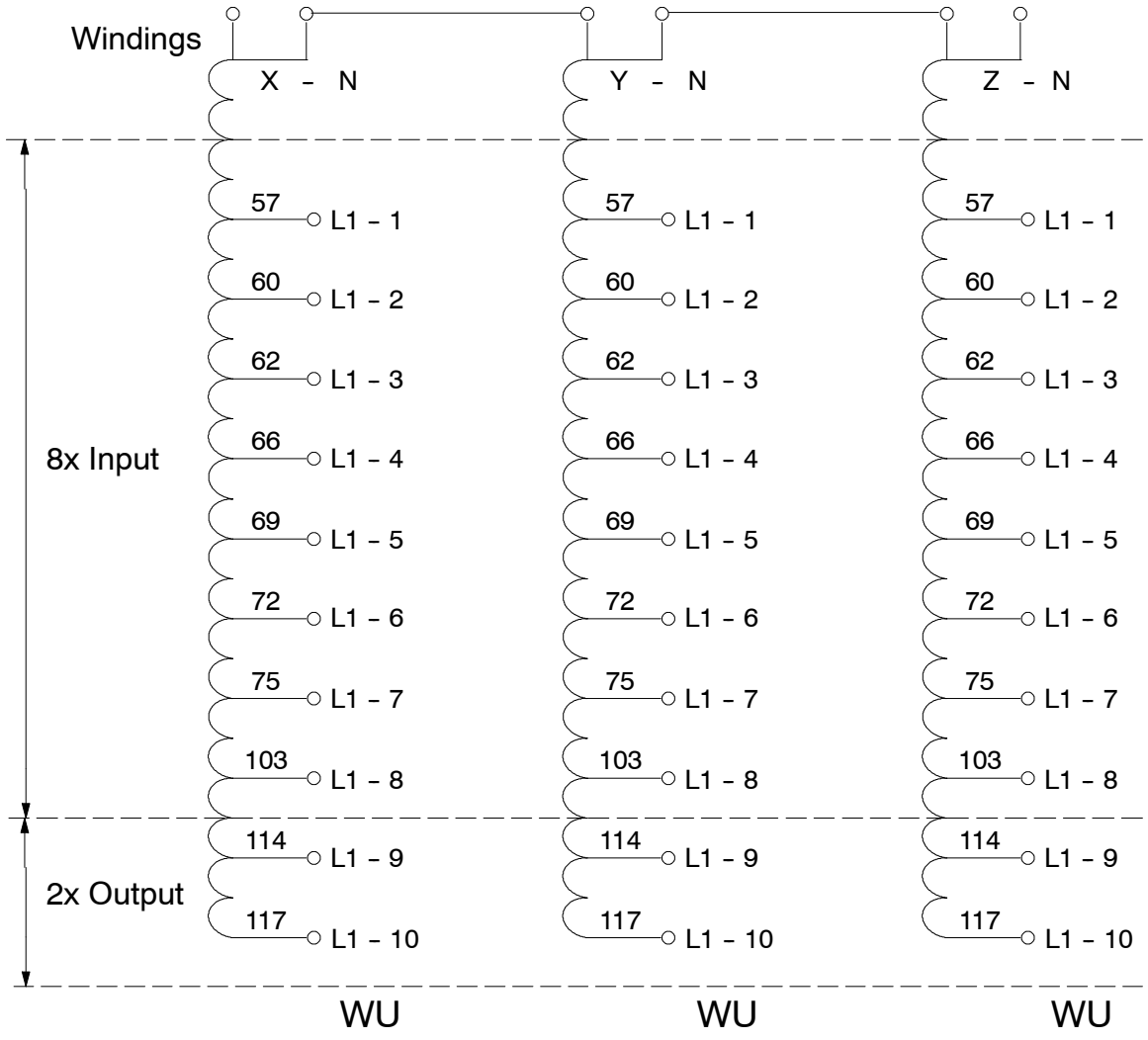

Windings and connection terminals

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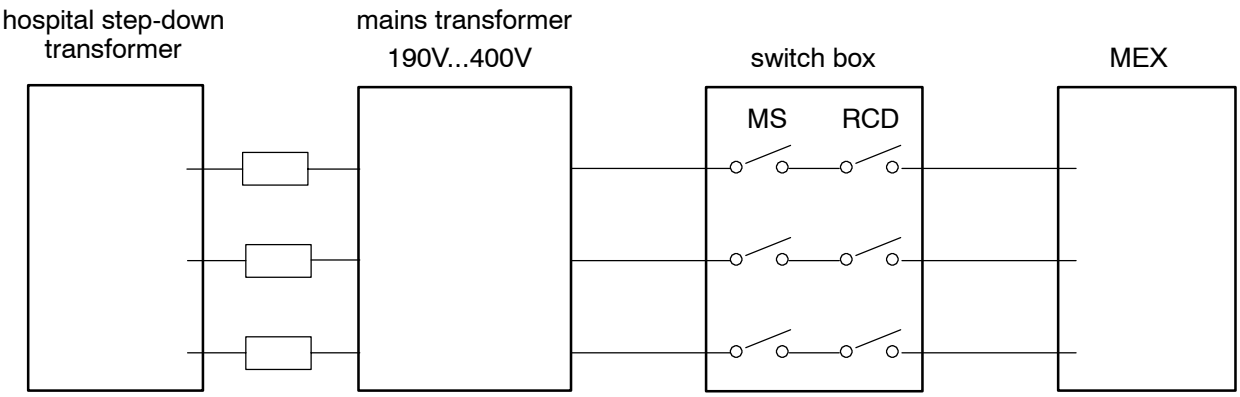

Fuse rate depends on the hospital mains supply and the power data of the X-ray generator, therefore please refer to the manual of the main transformer. (see table 6.3.1.)

A4 04-09-15 Sie.
9803 720 81002_Z4

Installation

Mains transformer 190V ... 400V

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R_0	mΩ
R_{Fuse}	5,5 mΩ
U_{input}	V_{AC}
U_{output}	V_{AC}
T^2 See table 6.3.1.	
Internal resistor switch box **R_3**	9,5 mΩ
Generator resistor **R_{XG}** See table 3.3.	mΩ
R_{Tr} See table 6.3.1.	mΩ
L_2	m
Cross section	AWG
Resistor R_2 L_2 x RCU	mΩ
L_4	m
Cross section	AWG
Resistor R_4 L_4 x RCU	mΩ
R_5 (R_2 + R_3 + R_4)	mΩ
R_{sec} (R_{XG} - R_5)	mΩ
P_{prim} (T^2 x R_{sec})	mΩ
R1 (R_{prim} - R_{Tr})	mΩ
L_1	m
RCU for L_1 (from Z-1) (R_1-R_{fuse}-R_0) / L_1	mΩm
AWG for L_1	

NOTE

For RCU and, respectively, AWG refer to table (see 6.3.2.)

Form sheet for calculations

Mains transformer 190V ... 400V

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